What are the long-term effects of the 2007 spring freeze and summer drought in the Southeast?

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Room 160 Plant Biotech Building Tuesday December 7 2010 11.00 am

Outline

- Topic introduction
  - Definition
  - Cause and indicators
- Current knowledge/issues
  - Effects of spring freeze and drought
  - Scenario in Tennessee
- Future directions

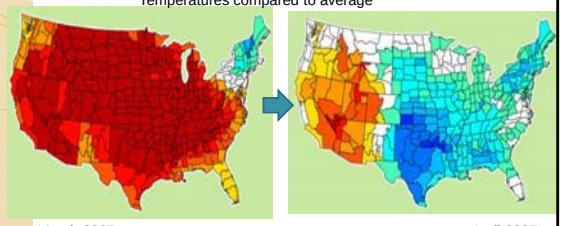
Topic introduction
Definition :

- Spring freeze – unusual warmth then freeze (extreme warm-cold fluctuation) (Gu et al, 2008)
- Drought - a condition of moisture deficit sufficient to have an adverse effect on vegetation, animals, and man over a sizeable area. (Warwick, 1975).

Cause and indicators

Spring freeze 2007

Temperatures compared to average



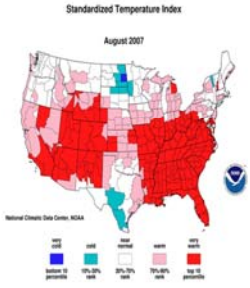
March 2007 April 2007

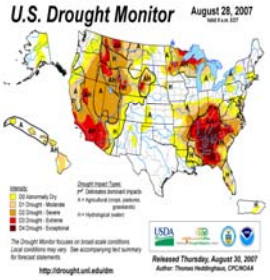
-0.5 -3.0 -1.0 1.0 3.0 5.0

https://applicationlink.labworks.org/serch/pdfs/Marino.pdf

Cause and indicators

2007 Drought





Current knowledge / issue

Effects of spring freeze

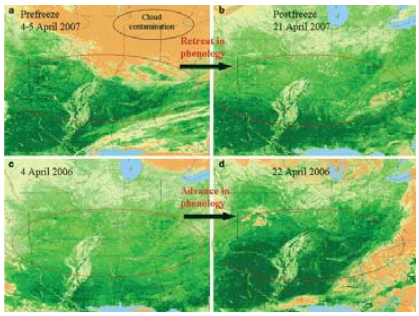
High temperature – early phenology development (premature development) eg from 100 to 85 days to spring leaf out

TN – development of crops such as pecan,apple peach and wheat were 2 to 3 weeks earlier before freeze

↓

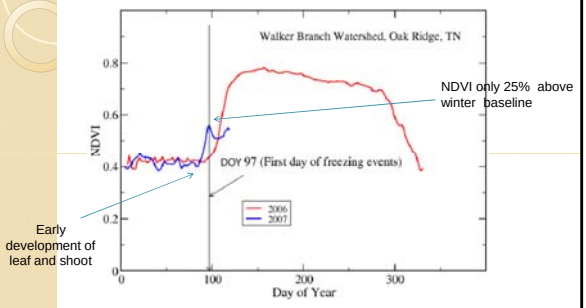
Freeze – killed newly formed leaves and shoots

Images of normalized difference vegetation index (NDVI) during spring freeze



https://applicationlink.labworks.org/serch/pdfs/Marino.pdf

Starting of growing seasons –leaf out



http://www.ncdc.noaa.gov/special-reports/2007-apr-cold-event.html

Location

- Not affected
  - Upland
  - Lake area & river reservoir adjacent vegetative (Gu et al, 2008)
- Affected – flat / ground (lower hill) especially in eastern Tennessee and northern Georgia

Forest – forest ridges brown
Plant canopies – elongated, expanded leaves and flowers – dark brown desiccated litter

2007 April 5, 4:20p.m

2007 April 22, 4:21p.m.

http://www.ornl.gov/info/ornlreview/v40_3_07/article08.shtml

Scenario in Tennessee

freeze

http://forestry.tennessee.edu/springfreeze07.htm

http://forestry.tennessee.edu/freezetwoweeks07.htm

Severely affected – tulip poplar, oaks and hickories
Not affected – blackberry, sugar maple and sweetgum

http://forestry.tennessee.edu/freezemonth07.htm

New buds – hickories and oaks, followed by yellow poplars and lastly red oaks, also ginkgos and dawn redwoods
Japanese maple – sprouting at three nodes back from the tips

Scenario in Tennessee

http://forestry.tennessee.edu/freezesixweeks07.htm

Brown leaves and dead blossoms can still be seen on the branches. Red oaks and hickories were re-leafing faster than yellow poplar
Most damage were located below 1,200 feet in Tennessee
Red and white oaks,hickories, yellow-poplar,hackberry and sycamore affected but not maples
Crown sparse with fewer,smaller and less dense leaves

http://forestry.tennessee.edu/freezetwomonths07.htm

New growth below the point of girdling
freeze damage
Carpenter bees and ticks - less

http://forestry.tennessee.edu/freezethreemonths07.htm

Dieback in yew can be seen

http://www.ncdc.noaa.gov/special-reports/2007-apr-cold-event.html

Affected States	Pre-Freeze	Post-Freeze
Alabama		
Winter Wheat	14% (04/01)*	36% (04/22)
Arkansas		
Winter Wheat	6% (04/01)	64% (04/23)
Corn	16% (04/08)	58% (04/22)
Pastures	15% (04/01)	25% (04/22)
Georgia		
Corn	3% (04/01)	26% (04/22)
Pastures	34% (04/01)*	49% (04/22)
Apples	0% (04/01)	99% (04/22)
Peaches	5% (04/01)	83% (04/22)
Tobacco	0% (04/01)	30% (04/22)
Illinois		
Winter Wheat	9% (04/01)	29% (04/23)
Alfalfa	NR	32% (04/22)
Red Clover	NR	32% (04/22)
Indiana		
Winter Wheat	12% (04/01)	30% (04/22)
Kansas		
Winter Wheat	4% (04/01)	41% (04/22)
Kentucky		
Corn	NR	39% (04/22)
Strawberries	NR	66% (04/22)
Missouri		
Winter Wheat	8% (04/01)	64% (04/23)
Pastures	17% (04/01)	39%% (04/22)

Affected States	**Pre-Freeze**	**Post-Freeze**
North Carolina		
Winter Wheat	3% (04/01)	39% (04/23)
Peaches	NR	98% (04/22)
Truck Crops	2% (04/01)	35% (04/22)
Irish Potatoes	6% (04/01)	30% (04/22)
Rye	1% (04/01)	58% (04/22)
Barley	1% (04/01)	55% (04/22)
Oats	0% (04/01)	31% (04/22)
South Carolina		
Winter Wheat	1% (04/01)	50% (04/22)
Corn	1% (04/01)	46% (04/22)
Pastures	11% (04/01)	25% (04/22)
Apples	NR	90% (04/22)
Peaches	NR	87% (04/22)
Tobacco	NR	48% (04/22)
Cucumbers	0% (04/01)	70% (04/22)
Snapbeans	0% (04/01)	70% (04/22)
Cantelopes	0% (04/01)	45% (04/22)
Watermelons	0% (04/01)	43% (04/22)
Oats	1% (04/01)	41% (04/22)
Tennessee		
Winter Wheat	3% (04/01)	84% (04/22)
Apples	0% (04/08)	91% (04/22)
Peaches	NR	98% (04/22)
Strawberries	NR	39% (04/22)
Pastures	31% (04/01)*	32% (04/22)
Virginia		
Peaches	2% (04/01)	86% (04/22)

Drought effects

- Virginia – dry environment suppressed fungus growth that can limit the gypsy moth population (caused 78,000 acres of forest defoliation compared to only 17,000 acres in previous year)

http://www.legis.state.wv.us/Reports/Agency_Reports/Agency_Reports_Docs/A03_FY_2007_184.pdf

- Presence of emerald ash borer in Fayatte county confirmed

- Large number of deer death caused by epizootic hemorrhagic disease (EHD) known as blue tongue disease, transmitted by biting midges

http://www.legis.state.wv.us/Reports/Agency_Reports/Agency_Reports_Docs/A03_FY_2007_184.pdf

- Alabama, Georgia - Fawn mortality increased – less nutrition and high predation rate on deer (Edwards, 2008)
- Large number of deer death caused by epizootic hemorrhagic disease (EHD) known as blue tongue disease, transmitted by biting midges
- However acorn production was abundant, due to tree stress

Consequences

- On terrestrial carbon cycle :
  - Disturbance on internal nutrient cycling -No remobilizing of leaf nutrient
  - Leaching to atmosphere or immobilized by microbes
  - Plant architecture altered – epicormic growth
  - Plant community structure affected – uneven impact from damaged canopy especially light penetration
  - Fruit crop affected – food source for wildlife

Future directions

- Increase concentration of carbon dioxide – reduce tolerance to low temperature / freezing (less stomata conductivity)
- Repeated freeze and thaw fluctuation lead to risk of xylem embolism and reduce xylem activities – crown dieback
- Freezing stress increase – snow cover decrease therefore thermal protection decline

Future directions

- Plant earlier or plant alternative species
- Naturally, plants and animals shift their ranges poleward or move to higher elevation – more research/study should be conducted related to climate change

References :

- Douglas, G.R. (2007) Annual Report 2007, West Virginia Department of Agriculture
- Edwards, D. (2008) Effects of the 2007 drought on wildlife and wildlife habitat.
- *Warwick, R.A., 1975, Drought hazard in the United States: A research assessment: Boulder, Colorado, University of Colorado, Institute of Behavioral Science, Monograph no. NSF/RA/E-75/004, 199 p.*
- *Gu, L., Hanson, P.J., Post W. M., Kaiser, D.P., Yang, B., Nemani, R., Pallardy, S. G. and Meyers, T. (2008). The 2007 Eastern US spring freeze: Increased cold damage in a warming world? Bioscience. Vol 58. No. 3 pp 253-262.*